Units and Measurements

Example Problems Based on Light Year, Astronomical Unit, Parsec, and Their Relationships

Problem 1: Light Year Calculation

Problem: Calculate the distance in kilometers that light travels in one year. (Speed of light $c = 3 \times 10^8$ m/s)

Solution:

1. Determine the number of seconds in one year:

$$1 \text{ year} = 365.25 \times 24 \times 60 \times 60 \text{ seconds}$$

$$= 31,557,600 \text{ seconds}$$

2. Calculate the distance light travels in one year:

$$\text{Distance} = c \times \text{time}$$

$$= 3 \times 10^8 \text{ m/s} \times 31,557,600 \text{ seconds}$$

$$= 9.46728 \times 10^{15} \text{ meters}$$

3. Convert meters to kilometers:

$$= 9.46728 \times 10^{12} \text{ kilometers}$$

Thus, the distance light travels in one year is approximately 9.46728×10^{12} kilometers.

Problem 2: Astronomical Unit (AU)

Problem: Convert 1 Astronomical Unit (AU) to kilometers. Given: 1 AU = 1.496×10^8 km.

Solution:

1. The conversion is direct:

$$1 \text{ AU} = 1.496 \times 10^8 \text{ kilometers}$$

So, 1 AU is 1.496×10^8 kilometers.

Problem 3: Parsec (pc)

Problem: Calculate the distance in kilometers for 1 parsec (pc). Given: 1 parsec = 3.086×10^{16} meters.

Solution:

1. Convert meters to kilometers:

$$1 \text{ parsec} = 3.086 \times 10^{16} \text{ meters} = 3.086 \times 10^{13} \text{ kilometers}$$

So, 1 parsec is 3.086×10^{13} kilometers.

Problem 4: Relationship between AU, Parsec, and Light Year

Problem: Show the relationship between AU, parsec, and light year. Given: 1 parsec = 206,265 AU, 1 light year = 63,241 AU.

Solution:

1. Express 1 parsec in terms of light years:

$$1 \text{ parsec} = 206,265 \text{ AU}$$

$$1 \text{ light year} = 63,241 \text{ AU}$$

2. Calculate the number of light years in 1 parsec:

$$\text{Number of light years in 1 parsec} = \frac{206,265 \text{ AU}}{63,241 \text{ AU/light year}}$$

$$= 3.26156 \text{ light years}$$

So, 1 parsec is approximately 3.26156 light years.

Additional Example Problems

1. **Problem**: If a star is 4.2 light years away, what is its distance in parsecs?

   Solution:

$$\text{Distance in parsecs} = \frac{\text{Distance in light years}}{3.26156}$$

$$= \frac{4.2}{3.26156} \approx 1.287 \text{ parsecs}$$

2. **Problem**: Calculate the distance in AU for a star located 10 parsecs away.

   Solution:

$$\text{Distance in AU} = 10 \text{ parsecs} \times 206,265 \text{ AU/parsec}$$

$$= 2,062,650 \text{ AU}$$

3. **Problem**: A planet is 5 AU from Earth. Convert this distance to kilometers.

   Solution:

$$\text{Distance in kilometers} = 5 \text{ AU} \times 1.496 \times 10^8 \text{ km/AU}$$

$$= 7.48 \times 10^8 \text{ kilometers}$$

4. **Problem**: A galaxy is 2 megaparsecs (Mpc) away from Earth. Convert this distance to light years.

   Solution:

$$\text{Distance in light years} = 2 \text{ Mpc} \times 10^6 \times 3.26156 \text{ light years/parsec}$$

$$= 6.52312 \times 10^6 \text{ light years}$$

5. **Problem**: The distance to a star is 50 parsecs. What is this distance in light years?

   Solution:

$$\text{Distance in light years} = 50 \text{ parsecs} \times 3.26156 \text{ light years/parsec}$$

$$= 163.078 \text{ light years}$$

6. **Problem**: If the Sun is 1 AU from Earth, how many parsecs is this distance?

   Solution:

$$\text{Distance in parsecs} = \frac{1 \text{ AU}}{206,265 \text{ AU/parsec}}$$

$$= 4.84814 \times 10^{-6} \text{ parsecs}$$

Key

1. 9.46728×10^{12} kilometers
2. 1.496×10^{8} kilometers
3. 3.086×10^{13} kilometers
4. 1 parsec ≈ 3.26156 light years
5. 1.287 parsecs
6. 2,062,650 AU
7. 7.48×10^{8} kilometers
8. 6.52312×10^{6} light years
9. 163.078 light years
10. 4.84814×10^{-6} parsecs